

1. INTRODUCTION

1.1 GENERAL DESCRIPTION

"Shamal," an Arabic word meaning "north," is also the name given to seasonal northwesterly winds that occur during the winter and summer in the Persian Gulf region. The characteristics of the two seasons' shamals are markedly different, so any discussion of these phenomena must recognize their differences.

The winter shamal, which occurs chiefly from November through March, is associated with mid-latitude disturbances that progress from west to east. It occurs following cold frontal passages and is characterized by strong northwesterly winds -- most prominently in December, January, and February -- accompanied by such adverse weather conditions as thunderstorms, turbulence, low visibilities, and high seas.

Although the winter shamal is a relatively rare event -- winds at most Gulf locations exceed 20 kt less than 5% of the time during the season -- it can not be considered operationally insignificant. The winter shamal sets in with such abruptness and force, that its irregularly occurring gale strength winds stand out in bold relief against a background of more common, lighter wind conditions.

The summer shamal generally occurs with little interruption from early June through mid-July. Its occurrence, which is associated with the relative strengths of the Indian and Arabian thermal lows, is usually much less significant than that of the winter shamal in terms of wind strength and accompanying weather conditions.

Because of its greater potential for adverse operational effects, only the winter shamal is examined in this study. Unless otherwise specified, the term "shamal" hereafter is understood to mean the winter event.

1.2 REPORT ORGANIZATION

Shamals can be characterized as being of two general types, based on duration: those which last 24-36 hours, and those which last for a typically longer period of 3-5 days. The differences between these two duration-types are cited in text and illustrations where appropriate.

Section 2 of this report describes the geography and topography of the Gulf region in which the shamals occur.

Section 3 discusses eight aspects of shamal occurrence:

- (1) Typical synoptic sequences of both duration-types
- (2) Variations from these typical sequences
- (3) Conditions related to onset
- (4) Duration of occurrence
- (5) Significant mesoscale weather phenomena
- (6) Wind structure
- (7) Sea and swell structure under shamal conditions
- (8) Associated atmospheric turbulence

Four appendices follow the main text, providing two case studies, a wind climatology, and forecast guidance.

Appendix A, a detailed case study of a typical 24-36 hr shamal, illustrates the concepts developed in the main text by presenting a series of surface analyses, upper air charts, DMSP visible and infrared satellite imagery, and discussions in text. The wide scope of the data in this case study provides an in-depth, analytic view of shamal occurrence that might not otherwise be available to the field observer working under operational conditions.

Appendix B examines the longer 3-5 day shamal. The available data is less, however, providing a level of information that would more likely be generally available to the operational forecaster.

Appendices C and D present a wind climatology and a series of forecasting rules-of-thumb, respectively.

1.3 ORDER OF PRESENTATION

In Section 3.1, which describes typical synoptic sequences, the 3-5 day shamal is discussed first, and the 24-36 hr shamal, second. In the appendices, by contrast, case study 1 (Appendix A) is the 24-36 hr event and case study 2 (Appendix B) is the 3-5 day event.

The order of presentation in the main text was selected because, from the standpoint of meteorological dynamics, the 24-36 hr sequence of events is contained within the 3-5 day sequence. Thus it is logical to discuss the longer and more inclusive sequence first and contrast the shorter one with it.

A reversal of this order was indicated in the case studies, simply because there is more information available for the short-duration shamal than for the longer one, and because the 24-36 hr event occurs more frequently. It is anticipated that the more detailed data given in Appendix A will enable the user to better understand the related, though less detailed, discussions of conditions and events given in Appendix B.